

Modern Concepts of Cardiovascular Disease

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THE CLINICAL APPLICATION OF ELECTROCARDIOGRAPHY

The increasing popularity of many unipolar leads in clinical electrocardiography has accentuated an old problem, never completely resolved in relation to the three conventional limb leads. The significance of abnormalities of the electrocardiogram to the physician responsible for the care of a patient has caused much discussion. Twenty years ago two extreme points of view were rather widely held regarding the method. Many practitioners held that electrocardiography was an ostentatious laboratory method, impressive to the patient, but practically useless in his management. Other physicians, and many of the laity, expected the electrocardiographer to furnish a complete cardiac diagnosis and outline of treatment by means of a tracing. The latter view is still common among non-medical persons but has almost completely disappeared in the profession. Considerable suspicion regarding the validity of abnormal findings persists, however, in the minds of many physicians.

This suspicious attitude is sustained by a tendency of some electrocardiographers to draw far-reaching conclusions from insufficient electrocardiographic evidence. More active and detailed educational measures are indicated to reduce the frequency with which curves are "over-interpreted" or wrongly interpreted to the detriment of a patient. Errors in evaluation occur most frequently in two circumstances; first, when an inadequately trained person makes the study, and second, when a trained electrocardiographer makes a report, without knowledge of the clinical problem, to a practitioner who knows little of the electrocardiographic method, but must use and evaluate the report. Such errors are at a minimum when a trained clinician and electrocardiographer interprets the tracing and uses the information it provides.

When a trained cardiologist uses a tracing made on one of his own patients, he follows a number of steps in study of the curve and the evaluation of its significance. Some of these steps are often more or less unconscious. Young electrocardiographers, enthusiastic about newly learned facts of the science, and practitioners who use the method only occasionally tend to neglect important steps in the evaluation of the curve. Others with adequate laboratory training, but lacking experience in handling the patients who provide the curves, also tend to neglect clinical evaluation.

Three separate steps are advisable:

1. Study of the curve as such.
2. Evaluation of the diagnostic significance of the tracing in relation to the clinical problem.
3. Evaluation of the prognostic significance of the tracing in relation to the clinical problem.

Study of the curve.

This requires only brief comment. It consists of standard operations designed to detect technical faults, standard measurements, identification of arrhythmias, a description of abnormalities present in the tracing and description of partially or fully developed patterns.

Evaluation of diagnostic significance.

Even when the study of the curve is entirely ade-

quate, the clinical evaluation represents an involved process. Only in the field of the identification of the arrhythmias does the electrocardiogram furnish authoritative evidence of clinical significance. No other method in common use is as accurate. In other fields electrocardiography is less certain, mainly because it provides no direct evidence regarding etiology and is not helpful in evaluating cardiac reserve.

An illustration of this weakness which has been completely worked out over the years involves the evaluation of bundle branch block tracings. Statistical evaluation of various series of this pattern, occurring in clinical practice, show conclusively that bundle branch block is usually associated with serious heart disease, but the pattern occurs occasionally in otherwise apparently normal hearts and in this circumstance may be compatible with a long, symptom-free life. The reason for this is obvious. The electrocardiogram shows only the fact that a major branch of the Purkinje system is interrupted. It furnishes no clue to the etiology of the process which caused the defect. Interruption of the bundle branch and the resulting conduction defect do not in themselves reduce the functional capacity of the heart noticeably, and the lesion is insignificant clinically if its etiology is such that it is a limited, non-progressive myocardial defect.

The frequency of occurrence of an incidental, clinically insignificant cardiographic finding in the presence of known organic heart disease is so small that for practical purposes it can be discarded, even though occasional error will occur. The errors which occur in this circumstance are usually much less important than those which are made when the heart is judged to be abnormal on the basis of cardiographic evidence alone. It is, therefore, advisable to maintain a different attitude in the evaluation of the tracing when good evidence of heart disease exists apart from the cardiogram, than when uncertainty exists about the presence of heart disease.

Some deviations from normal standards in the electrocardiogram are commonly regarded as important and others as relatively unimportant. Nearly every text recognizes this. Some, for example Burch and Winsor¹, distinguish between findings which constitute definite, suggestive, or uncertain evidence of myocardial disease. Assignment of findings to these categories, of course, is based upon an estimate of the frequency of association of abnormalities with significant or insignificant clinical conditions. The frequency of such associations has not been determined accurately and probably never can be because so many variables are involved, including sex, age, body build, hereditary background, etc., but the concept of frequency is important and useful in the clinical evaluation of tracings when uncertainty exists as to the presence of heart disease.

This point can be illustrated by means of a table. If some specific measurement, for example amplitude of T-II, is considered, some particular value could be determined which occurs half the time in the presence of significant heart disease and half the time as an insignificant finding. In the case of T-II in an average population, this measurement would

be in the neighborhood of one millimeter. Assuming this distribution of such a low T-II and using 100 tracings from 100 cases which represent a random sample of an average population, the following table might be constructed.

Estimated Distribution of Low T-II in 100 EKG's from 100 Individuals Taken at Random

	Cases	Normal T-II	Low T-II
EKG's	100	96	4
Normal hearts	96	94	2
Abnormal hearts	4	2	2

Horizontally in the top row one might expect to find that of the 100 tracings, 96 would show a T-II of normal amplitude and 4 of low amplitude. Reading vertically in the first column, one might expect to find that 96 of the individuals would have normal hearts and 4 abnormal hearts. When the assumptions made in the top row and the first column are added to the assumption that 50 percent of the low T waves under consideration occur in normal hearts, the table can be completed. The last column is of interest to the practical electrocardiographer in evaluation of the low T wave. If at the end of the clinical study the low T wave is the only abnormal finding, the tracing provides very uncertain evidence of heart disease. Since most of the four patients who have abnormal hearts will show evidence of it by other means than the electrocardiogram, absence of such evidence increases the probability that the low T wave is insignificant. On the other hand, if an abnormal heart is known to be present, the probability is great that the low T wave is the result of abnormality of the myocardium, since the incidence of low T-II in diseased hearts is 50 percent and only 2 of 96, or 2.1 percent of the normal hearts have low T waves. Therefore, there are 2.1 chances out of 50, or a 4.2 percent chance, that the low T-II is an insignificant finding when organic heart disease is known to be present.

Obviously, this mathematical analysis is valuable only in an illustrative sense. The frequency of organic heart disease varies from 1 or 2 percent in a population of school children to 10 percent or more in aged groups. The frequency as encountered in populations of patients varies according to the clinical indications employed for making cardiograms as well as with the patient group. These and other factors modify the first column. The frequency of various cardiographic abnormalities varies greatly, which modifies the first row; and the regularity of association of specific abnormalities of the tracing with diseased hearts is variable, which modifies the third column. Because of the large number of variables, a large number of such tables would be necessary to make them of practical use.

The clinical points which the table emphasizes are concerned with the fact that the cardiogram alone usually does not prove that clinical heart disease is present when a single abnormality exists in the tracing. Even abnormalities which are commonly regarded as "definite" evidence of myocardial disease do not always indicate that clinically significant disease is present. For example, elevation of the S-T interval in the presence of an inverted T wave is usually regarded as strong evidence of a destructive myocardial lesion, but Myers² has shown that this pattern may occur over the right precordium in the absence of such a lesion. If one concludes that myocardial disease is present on the basis of such a finding, he will be in error occasionally, but if he concludes that disease is present because T-I is low, he will be in error frequently.

Of course, if two or more abnormalities are present in the same curve, the probability of disease is greatly increased. When certain patterns are well developed, clinical inferences which are precise and useful can be drawn from the tracing alone.

When disease is known to be present, the probabilities of error are altered. Errors resulting from

"over-interpretation" are less frequent and usually much less dangerous to the patient. An example of this that frequently arises is related to electrocardiographic diagnosis of left ventricular hypertrophy. While a fully developed hypertrophy pattern is highly reliable, many instances of partially developed patterns are encountered. When such a pattern is encountered in the presence of hypertension or some other lesion known to cause hypertrophy, it is presumptive evidence of heart strain, but when encountered in the absence of known heart disease, it may be of little significance beyond indicating the need for careful diagnostic study. Often minor changes that are insignificant as isolated findings are valuable in making diagnosis precise when accompanied by other evidence of disease.

Evaluation of prognostic significance:

This portion of electrocardiographic evaluation requires particular restraint. While many patterns have definite statistical correlations with prognosis of morbidity or mortality, very few tracings provide accurate evidence when considered apart from other data. This clinical weakness results from the complete inability of the cardiogram to furnish evidence of etiology. All associations of etiology with patterns are presumptive and based on probability.

The frequent association of a prominent Q-III with posterior myocardial infarction gave rise to numerous erroneous unfavorable prognoses before it was recognized that many such waves were the result of completely innocuous rotations of the heart. Almost every newly identified pattern is responsible for a regiment of fearful, unnecessarily invalidated patients before the limitations of the pattern are established.

Such isolated cardiographic findings place considerable responsibility on the cardiologist. He must study his patient exhaustively. If, after such study, he is unable to elucidate adequate supporting evidence of a diagnosis which involves a serious prognosis, he must make a decision. A bad prognosis is easy and safe to make. Patients are rarely critical of one who makes a bad prognosis. If the prognosis is right, the doctor is congratulated, and if time proves it to be wrong, the patient usually believes his doctor was responsible for saving his life. A good prognosis always involves danger to the professional reputation, however, because one can never be made with complete assurance and the doctor gets no credit for able therapy. The clinician must decide to risk his own reputation occasionally by making a good prognosis when its probability is high even though he may be criticized if an error is made. Most physicians take such risks—consider the surgeon who operates in the presence of a high probability of mortality—but some who would not hesitate to disregard a murmur of questionable significance when making a prognosis will be unduly influenced by abnormal T waves.

It has been shown that the clinical evaluation of electrocardiographic abnormalities is difficult and involved. It has been suggested that tracings are more often weighted too heavily than too lightly in making clinical decisions. Finally, attention should be called to the fact that these difficulties are enhanced when the first step, the study of the curve, is made by a cardiographer who does not know the clinical problem; and the second and third steps, the evaluation of the tracing for its diagnostic and prognostic implications is made by a physician unfamiliar with electrocardiography. Under these circumstances, consultation is nearly always necessary.

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